Selecting Biophysical Indicators for Economic Valuation of Nonuse Ecosystem Services

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Nonuse Values

- Portions of total economic value (WTP or WTA) that are unobtainable using indirect measurement techniques that rely on observed (market) behavior.
- Values that can be held without behavioral evidence.
- No behavioral trail → only measurable using stated preference methods.
- Common types of nonuse values include (a) existence values, (b) bequest values, (c) altruistic values.
- Focus here on existence values, but similar findings apply to other types of nonuse value.

Why are These Values Important? An Illustrative Example

- EPA Benefits Analysis for the Final Section 316(b) Existing Facilities Rule EPA-821-R-14-005 estimates nonuse benefits of reductions in impingement mortality and entrainment (IM&E).
- Estimates assume that households *only* hold nonuse values for IM&E reductions in their own region (Northeast, Southeast, Inland and Pacific) → lower bound estimates.
- National nonuse value of IM&E reductions were *$1.1 billion per year* (Table 11-13). Estimated using stated preference survey by US EPA.
  - Modest per household; large in aggregate. This is a typical pattern.
- National benefits *excluding* these estimated values were *$28.7 million* per year (p. 13-8).

Challenges for Indicator Development

- Expectations exist regarding types of ecological outcomes associated with existence values, but few necessary rules.
- In theory, a person can hold an existence value for almost anything.
- Sometimes the same indicators can be used for use and existence (or other nonuse) values, where these values are motivated by the same underlying ecological change.
- But, indicators unlikely to serve as good indicators for use values can be suitable indicators in a existence context.
- What does the economic literature tell us about biophysical quantities and qualities valued by existence beneficiaries?

Where Can We Obtain Insight?

- Observable human behaviors do not provide a means to quantify existence values or identify superior indicators.
- Insight is generally gained through methods such as
  - Stated preference techniques
  - Focus groups, interviews and other qualitative approaches
  - Decades of data from these methods provides a foundation but does not answer all questions definitively.

Evidence to Guide Indicator Development—What Do We Know?

- Existence values are often associated with
  - Things viewed as characteristic of a location— “what makes this place special”
  - Unique, rare or threatened ecosystems or species
  - Things with established cultural or historical linkages
  - Things that provide large use values (use and nonuse values are often correlated)
  - Maintaining functional ecosystems in a holistic sense.
- Start with understanding underlying *motivation* for value.
- Example: Focus group respondents expressing values for the condition or “health” of the ecosystem as a whole, distinct from individual species or components of the system.

Evidence to Guide Indicator Development—What Do We Know?

- Good indicators for valuation should be (Schultz et al. 2012):
  - Measurable: Clearly stated relationship to ecological data or model results.
  - Interpretable: Understood similarly by respondents and scientists.
  - Applicable: Directly and proximally related to the value it is intended to measure.
- Would people be willing to pay for a change in the indicator, assuming (a) no personal use, and (b) no other ecological changes? Do they understand what it conveys?

Examples of Indicators Used to Capture Nonuse Values

- Wildlife Species: Official status (e.g., threatened), abundance, distribution, viability, diversity, mortality.
- IBIs and similar multimetric indicators to capture holistic ecosystem condition (Johnston et al. 2011).
- Land cover/use, where these land features are valued directly (e.g., due to cultural relevance).
- Water and air quality measures (e.g., WQIs or ladders); sometimes direct pollution reductions.
- Measures of aesthetics for iconic assets (e.g., clarity for Lake Tahoe, visibility for Grand Canyon).

Example—An Index of Biotic Integrity (Pawtuxet Watershed (RI) Fish Passage Restoration)

THE AQUATIC ECOLOGICAL CONDITION SCORE SHOWS WHETHER A RIVER IS NATURAL OR ALTERED BY HUMANS

The Aquatic Ecological Condition Score is a 0 - 100 score representing how close a river is to the most natural, undisturbed area found in Rhode Island. Higher scores mean the river is more natural.

The following information is combined to make the final score:

Measurements Added Together to Form the Aquatic Ecological Condition Score	What Each Measure Means
Fish Abundance	Total number of fish in the river.
Number of Mussel Species	Mussel species that are present.
Number of Native Species	Fish species present that are natural to Rhode Island.
Number of Sensitive Species	Fish species present that are sensitive to human impacts.
Number of Feeding Types	Different ways that fish species in the river eat.
Percent Native Individuals	Percent of individual fish that are natural to Rhode Island.
Percent Migratory Individuals	Percent of individual fish that migrate to the ocean.
Percent Tumor Free	Percent of individual fish that do not have tumors.

Question 5. Projects **A** and **B** are possible restoration projects for the Pawtuxet River, and the **Current Situation** is the status quo with no restoration. Given a choice between the three, how would you vote?

Effect of Restoration	Current Situation (no restoration)	Restoration Project A	Restoration Project B
Fish Habitat	0% 0 of 4347 river acres accessible to fish	5% 225 of 4347 river acres accessible to fish	20% 900 of 4347 river acres accessible to fish
Population Survival Score	0% Chance of 50-year survival	30% Chance of 50-year survival	30% Chance of 50-year survival
Catchable Fish Abundance	80% 116 fish/hour found out of 145 possible	70% 102 fish/hour found out of 145 possible	70% 102 fish/hour found out of 145 possible
Fish-Dependent Wildlife	55% 20 of 36 species native to RI are common	80% 28 of 36 species native to RI are common	60% 22 of 36 species native to RI are common
Aquatic Ecological Condition Score	65% Natural condition out of 100% maximum	70% Natural condition out of 100% maximum	80% Natural condition out of 100% maximum
Public Access	Public **CANNOT** walk and fish in area	Public CANNOT walk and fish in area	Public CAN walk and fish in area
$ Cost to your Household per Year	**$0** **Increase in Annual Taxes and Fees**	**$15** **Increase in Annual Taxes and Fees**	**$25** **Increase in Annual Taxes and Fees**
HOW WOULD YOU VOTE? (CHOOSE ONE ONLY)	☐ I vote for **NO RESTORATION**	☐ I vote for **PROJECT A**	☐ I vote for **PROJECT B**

Households Value IBI Improvements—Holding Use Value Indicators Constant

- IBI calculated as an unweighted linear combination of eight unimetric sub-indices on a 0-100 relative scale.
- Reference condition based on Wood-Pawcatuck considered to be most pristine in Rhode Island.

Variable	**WTP**	**Percentiles (1%, 99%)**	**Pr > |t|**
acres	1.0910	(0.39, 2.03)	<0.01
PVA	0 .4136	(0.11, 0.86)	<0.01
access	27.3285	(15.87, 43.70)	<0.01
IBI	**1.1879**	**(0.01, 2.42)**	**<0.01**
catch	0.0688	(-0.38, 0.56)	0.72
wildlife	0.6369	(0.15, 1.17)	<0.01

Example from US EPA 316(b) Regulatory Analysis—Fish Mortality and IBI

THIS SURVEY IS SIMILAR TO A PUBLIC VOTE

The next part of this survey will ask you to consider different types of policies to protect fish, and indicate how you would vote. Effects of each possible policy will be described using the following scores:

Effect of Policy	What It Means
Commercial Fish Populations (Fish Used by People)	A score between 0 and 100 percent showing **the overall health of commercial and recreational fish populations**. Higher scores mean more fish and greater fishing potential. A score of 100 means that these fish populations are at a size that maximizes long-term harvest; 0 means no harvest. **The current score in Northeast waters is 42.**
Fish Populations (All Fish)	A score between 0 and 100 percent showing **the estimated size of all fish populations** compared to natural levels without human influence. A score of 100 means that populations are the largest natural size possible; 0 means no fish. **The current score in Northeast waters is 26.**
Fish Saved (per Year)	A score between 0 and 100 percent showing the **reduction in young fish lost** compared to current levels. A score of 100 would mean that no fish are lost in cooling water intakes (all fish would be saved because of the new policy). **The current score in Northeast waters is 0.** This represents the status quo (no policy) with about 12% of plants already using advanced cooling systems.
Condition of Aquatic Ecosystems	A score between 0 to 100 percent showing **the ecological condition of affected areas**, compared to the most natural waters in the Northeast. The score is determined by many factors including water quality and temperature, the health of aquatic species, and habitat conditions. Higher scores mean the area is more natural. **The current score in Northeast waters is 50.**
$ Cost per Year	How much the policy will **cost your household, in unavoidable price increases for products and services you buy, including electricity and common household products.**

Question 5. Assume that Options A and B would require a different mix of filters and closed cycle cooling in different areas. Assume all types of fish are affected. How would you vote?

Policy Effect NE Waters	Current Situation (No policy)	Option A	Option B
Commercial Fish Populations (in 3-5 Years)	42% (100% is populations that allow for maximum harvest)	48% (100% is populations that allow for maximum harvest)	48% (100% is populations that allow for maximum harvest)
Fish Populations (all fish) (in 3-5 Years)	26% (100% is populations without human influence)	28% (100% is populations without human influence)	30% (100% is populations without human influence)
Fish Saved per Year (Out of 1.1 billion fish lost in water intakes)	0% No change in status quo	50% 0.6 billion fish saved	95% 1.0 billion fish saved
Condition of Aquatic Ecosystems (in 3-5 Years)	50% (100% is pristine condition)	51% (100% is pristine condition)	52% (100% is pristine condition)
$ Increase in Cost of Living for Your Household	$0 No cost increase	$60 per year ($5 per month)	$72 per year ($6 per month)
HOW WOULD YOU VOTE? (CHOOSE ONE ONLY)	☐ I would vote for NO POLICY	☐ I would vote for OPTION A	☐ I would vote for OPTION B

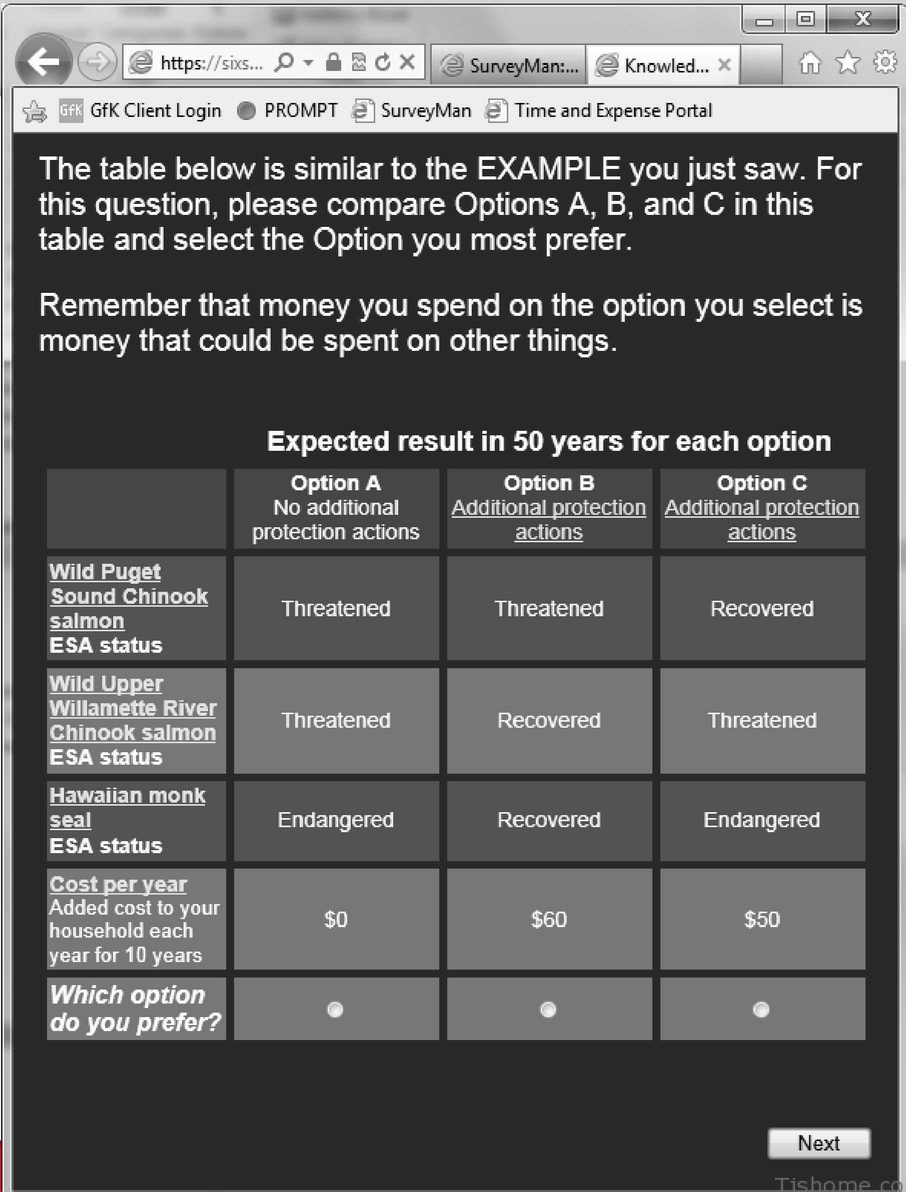
Significant WTP for Mortality Change and Sometimes for Aquatic Condition

	Mean	90% Confidence Interval (Simulated Empirical Distribution)	
		5th	95th
Northeast			
com_fish	**$10.30**	$6.45	$14.86
fish_pop	**$3.09**	-$4.53	$10.89
fish_saved	**$1.44**	$0.95	$2.07
aquatic	**$9.76**	$1.44	$19.01
Southeast			
com_fish	**$2.10**	$0.16	$4.11
fish_pop	**-$0.69**	-$3.81	$2.48
fish_saved	**$0.62**	$0.42	$0.83
aquatic	**$1.43**	-$2.01	$4.75

Results Vary Across Regions

	Mean	90% Confidence Interval (Simulated Empirical Distribution)	
		5^{th}	95^{th}
Pacific			
com_fish	**$5.37**	-$1.37	$13.60
fish_pop	**$7.71**	-$2.32	$18.53
fish_saved	**$1.77**	$1.07	$2.62
aquatic	**$15.32**	$5.01	$27.48
Inland			
com_fish	**$0.69**	-$0.67	$2.08
fish_pop	**$0.28**	-$1.83	$2.48
fish_saved	**$0.50**	$0.28	$0.70
aquatic	**$1.47**	-$0.78	$3.68

An Example Using Species ESA Status



The table below is similar to the EXAMPLE you just saw. For this question, please compare Options A, B, and C in this table and select the Option you most prefer.

Remember that money you spend on the option you select is money that could be spent on other things.

Expected result in 50 years for each option

	Option A No additional protection actions	**Option B** Additional protection actions	**Option C** Additional protection actions
Wild Puget Sound Chinook salmon ESA status	Threatened	Threatened	Recovered
Wild Upper Willamette River Chinook salmon ESA status	Threatened	Recovered	Threatened
Hawaiian monk seal ESA status	Endangered	Recovered	Endangered
Cost per year Added cost to your household each year for 10 years	$0	$60	$50
Which option do you prefer?	○	○	○

Next

- Illustrative choice question and species ranges.
- For nearly all individuals these are existence values.
- Example of “iconic” assets.

Willingness to Pay for Status Improvements (t=threatened; r=recovered)

Variable	WTP
Monk Seal_t	$24.53**
Monk Seal_r	$58.84***
UWR Chinook_r	$27.38***
PS Chinook_r	$22.78**

Summary Comments

- The literature provides insight into indicators that can be successful in existence valuation case studies.
- Supported by unpublished data from hundreds of focus groups.
- This is not the same as identifying a generalizable set of biophysical existence value indicators.
- There is evidence of existence value for ecological condition, but controversy over multimetric indicators.
  - These indicators should be taken seriously…
- It is important to consider the “resolution” at which non-experts understand indicators.
- Greater attention to these issues is required.

Partial List of Relevant Citations

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